



EX2108/ EX2116

VTI TRIGGER BUS EXPANDER

USER'S MANUAL

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VTI Instruments Corp.

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CERTIFICATION

VTI Instruments Corp. (VTI) certifies that this product met its published specifications at the time of shipment from the factory. VTI further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

The product referred to herein is warranted against defects in material and workmanship for a period of one year from the receipt date of the product at customer's facility. The sole and exclusive remedy for breach of any warranty concerning these goods shall be repair or replacement of defective parts, or a refund of the purchase price, to be determined at the option of VTI.

For warranty service or repair, this product must be returned to a VTI Instruments authorized service center. The product shall be shipped prepaid to VTI and VTI shall prepay all returns of the product to the buyer. However, the buyer shall pay all shipping charges, duties, and taxes for products returned to VTI from another country.

VTI warrants that its software and firmware designated by VTI for use with a product will execute its programming when properly installed on that product. VTI does not however warrant that the operation of the product, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The warranty shall not apply to defects resulting from improper or inadequate maintenance by the buyer, buyer-supplied products or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

VTI Instruments Corp. shall not be liable for injury to property other than the goods themselves. Other than the limited warranty stated above, VTI Instruments Corp. makes no other warranties, express or implied, with respect to the quality of product beyond the description of the goods on the face of the contract. VTI specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

RESTRICTED RIGHTS LEGEND

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VTI Instruments Corp.
2031 Main Street
Irvine, CA 92614-6509 U.S.A.

DECLARATION OF CONFORMITY

Declaration of Conformity According to ISO/IEC Guide 22 and EN 45014

MANUFACTURER'S NAME	VTI Instruments Corp.
MANUFACTURER'S ADDRESS	2031 Main Street Irvine, California 92614-6509
PRODUCT NAME	8/16 Port Trigger Bus Expander
MODEL NUMBER(S)	EX2108/16
PRODUCT OPTIONS	All
PRODUCT CONFIGURATIONS	All

VTI Instruments Corp. declares that the aforementioned product conforms to the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/366/EEC (inclusive 93/68/EEC) and carries the "CE" mark accordingly. The product has been designed and manufactured according to the following specifications:

SAFETY	EN61010 (2001)
EMC	EN61326 (1997 w/A1:98) Class A CISPR 22 (1997) Class A VCCI (April 2000) Class A ICES-003 Class A (ANSI C63.4 1992) AS/NZS 3548 (w/A1 & A2:97) Class A FCC Part 15 Subpart B Class A EN 61010-1:2001

I hereby declare that the aforementioned product has been designed to be in compliance with the relevant sections of the specifications listed above as well as complying with all essential requirements of the Low Voltage Directive.

February 2007



A handwritten signature in black ink, appearing to read 'Steve Mauga'.

Steve Mauga, QA Manager

GENERAL SAFETY INSTRUCTIONS

Review the following safety precautions to avoid bodily injury and/or damage to the product. These precautions must be observed during all phases of operation or service of this product. Failure to comply with these precautions, or with specific warnings elsewhere in this manual, violates safety standards of design, manufacture, and intended use of the product.

Service should only be performed by qualified personnel.

TERMS AND SYMBOLS

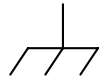
These terms may appear in this manual:

- WARNING** Indicates that a procedure or condition may cause bodily injury or death.
- CAUTION** Indicates that a procedure or condition could possibly cause damage to equipment or loss of data.

These symbols may appear on the product:



ATTENTION - Important safety instructions



Frame or chassis ground



Indicates that the product was manufactured after August 13, 2005. This mark is placed in accordance with *EN 50419, Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE)*. End-of-life product can be returned to VTI by obtaining an RMA number. Fees for take-back and recycling will apply if not prohibited by national law.

WARNINGS

Follow these precautions to avoid injury or damage to the product:

- Use Proper Power Cord** To avoid hazard, only use the power cord specified for this product.
- Use Proper Power Source** To avoid electrical overload, electric shock, or fire hazard, do not use a power source that applies other than the specified voltage.
- Use Proper Fuse** To avoid fire hazard, only use the type and rating fuse specified for this product.

WARNINGS (CONT.)

Avoid Electric Shock

To avoid electric shock or fire hazard, do not operate this product with the covers removed. Do not connect or disconnect any cable, probes, test leads, etc. while they are connected to a voltage source. Remove all power and unplug unit before performing any service. ***Service should only be performed by qualified personnel.***

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground.

Operating Conditions

To avoid injury, electric shock or fire hazard:

- Do not operate in wet or damp conditions.
 - Do not operate in an explosive atmosphere.
 - Operate or store only in specified temperature range.
 - Provide proper clearance for product ventilation to prevent overheating.
 - DO NOT operate if any damage to this product is suspected.
- Product should be inspected or serviced only by qualified personnel.***



Improper Use

The operator of this instrument is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired. Conformity is checked by inspection.

SUPPORT RESOURCES

Support resources for this product are available on the Internet and at VTI Instruments customer support centers.

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SECTION 1

INTRODUCTION

OVERVIEW

The EX2108 and EX2116 provide 8- and 16-port VTI trigger bus expansion, respectively, for use with the EX1629 strain gage measurement system. As the trigger bus expanders share similar functionality, they will be referred to as “EX2108/16” when similarities are discussed. The EX2108/16 allows multiple trigger bus chains to expand from a single master chain, providing the capability to create larger channel count systems while still maintaining measurement synchronization.

The physical constraints of the EX1629 VTI trigger bus also apply to the EX2108/16. Each chain is limited to 20 devices per chain. The EX2108 can expand the master chain to include seven more chains of up to 20 devices each, expanding the test system 160 devices if necessary. The EX2116 allows for the addition of fifteen such chains, allowing for the creation of a 320 device system. Chaining multiple trigger bus expanders together allows for even larger systems to be created, covering a larger physical area.

The EX2108/16 trigger bus ports provide buffering and termination, making each port an end-point on separate trigger chains. This internal termination eliminates the need for end termination blocks on the EX2108/16. External termination blocks, however, are still required on the terminal devices in a chain (see Figure 1-1).

NOTE

The EX2108/16 provides compatibility with the Driven Mode specification defined by the LXI Standard 1.0. The EX2108/16 does not provide LXI compliance in the Wired-OR Mode or Star Trigger functionality as defined in the LXI Standard.

While discussing the operation of the EX2108 and EX2116, certain terminology will be used to describe a device’s location or connectivity. Figure 1-1 provides a topological overview of a multi-expander system and provides descriptions for each device.

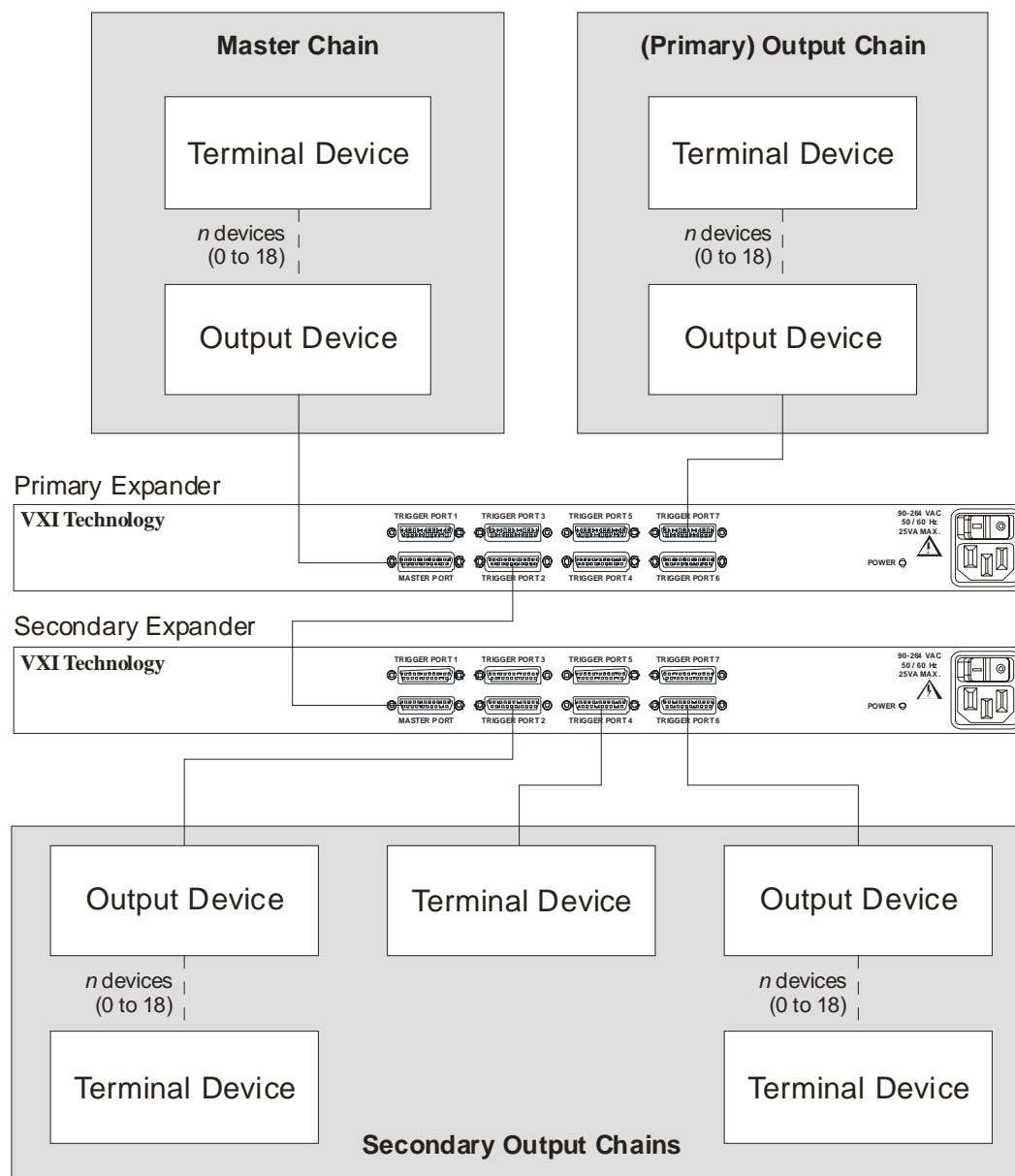


FIGURE 1-1: EX2108/16 SYSTEM TERMINOLOGY

EX2108/16 SPECIFICATIONS

GENERAL SPECIFICATIONS	
NUMBER OF PORTS	
EX2108	8 VTI trigger bus ports
EX2116	16 VTI trigger bus ports
OPERATING TEMPERATURE	
	0 °C to 50 °C
TRIGGER CHANNEL BANDWIDTH	
	100 MHz
POWER INPUT	
	(90 – 264) V ac, (50/60) Hz, 25 VA maximum
DEVICES PER CHAIN	
	20 maximum
MAXIMUM CHAIN LENGTH	
	20 m
DIMENSIONS	
	1.75" H x 17.5" W x 14.4" D

MAXIMIZING MEASUREMENT PERFORMANCE

Multi-Expander Test Systems

Creating multi-expander test systems requires accounting for the synchronization skew between EX2108/16s. The EX2108/16 retransmits the trigger signals with a low synchronization skew between ports such that devices placed an equal distance from the expander will see similar trigger arrival times. When interconnecting EX2108/16s, trigger signals must travel the length of the cable between expanders before retransmission. Consideration of this extra length may be required in system construction due to the propagation delay experienced between the devices connected to the separate EX2108/16 expanders. Careful analysis and planning of the test system can minimize these effects.

SECTION 2

PREPARATION FOR USE

OVERVIEW

This section provides information on setting up the EX2108/16 for use. It covers hardware installation, input connections, and trigger port configuration.

UNPACKING

When the EX2108/16 is unpacked from its shipping carton, the contents should include the following items:

- EX2108/16 LXI Trigger Bus Expander
- Power line cord
- *EX2108/16 User's Manual* (this manual)
- *VTI Instruments Corp. Drivers and Product Manuals CD*

All components should be immediately inspected for damage upon receipt.

INSTALLATION LOCATION

The EX2108/16 is designed to be largely insensitive to external electrical, magnetic, and thermal disturbances. The air vents on the sides of the EX2108/16 should not be blocked.

The EX2108/16 design allows for flexible rack mounting by providing front or rear attachable rack mount brackets. The brackets allow optimal positioning of the trigger bus connectors in the rack. The rack mount brackets are easily attached and removed using a Philips screwdriver.

INPUT CONNECTIONS / WIRING

The following cables are available through VTI Instruments Corp. for use with the EX2108/16:

Part Number	Description
52-0515-003	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 0.3M
52-0515-010	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 1M
52-0515-015	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 1.5M
52-0515-030	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 3M
52-0515-100	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 10M
52-0515-170	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 17M
52-0515-200	ASSY, CABLE, LXI TRIGGER BUS INTERCONNECT, 20M

TABLE 2-1: INTERCONNECT CABLES

VTI TRIGGER BUS

The following figure provides information for the pin locations and their signals for the EX2108/16's DB-25 connectors.

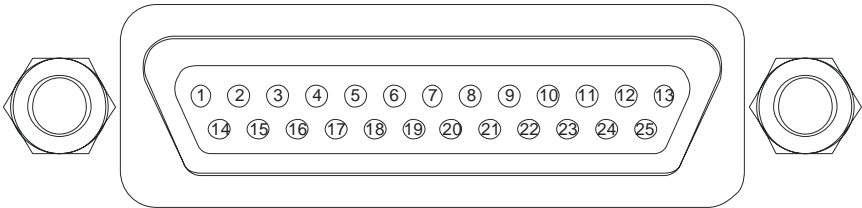


FIGURE 2-1: TRIGGER BUS DB-25 CONNECTOR

Pin	Signal	Pin	Signal
1	+3.3 V	14	RP_TRIG_P0
2	GND	15	RP_TRIG_N0
3	RP_TRIG_P1	16	RESERVED
4	RP_TRIG_N1	17	RP_TRIG_P2
5	GND	18	RP_TRIG_N2
6	RP_TRIG_P3	19	GND
7	RP_TRIG_N3	20	RP_TRIG_P4
8	GND	21	RP_TRIG_N4
9	RP_TRIG_P5	22	GND
10	RP_TRIG_N5	23	RP_TRIG_P6
11	RESERVED	24	RP_TRIG_N6
12	RP_TRIG_P7	25	RESERVED
13	RP_TRIG_N7		

TABLE 2-2: TRIGGER BUS CONNECTOR PIN ASSIGNMENTS

SECTION 3

BASIC OPERATION

INTRODUCTION

This section expands on the description of the EX2108/16's features and explains how to best use them.

REAR PANEL LAYOUT

The rear panel of the EX2108/16 has eight and sixteen trigger bus connectors, respectively. The MASTER PORT must connect to the chain containing the device that is configured as a master in the test system (see the master device's *user's manual* for more information on configuration). TRIGGER PORTs retransmit the MASTER PORT input signals in one of two different routing modes.

As stated in Section 1, the TRIGGER PORTs of the VTI trigger bus expanders are internally terminated, eliminating the need for external termination blocks on any of the EX2108/16 ports. The terminal device in a trigger bus chain, however, still requires termination blocks.



FIGURE 3-1: EX2108 REAR PANEL

ROUTING MODE CONFIGURATION

The routing modes of the EX2108/16 are specific to EX1629 trigger bus use. The EX1629 synchronization scheme uses four trigger bus channels. The EX2108/16 route these signals from the MASTER PORT to the TRIGGER PORTs. The EX2108/16 has two routing modes, *Daisy-Chain Extender Mode* and *Hybrid Star/Daisy-chain Mode*, which provide similar, yet slightly different, capabilities. The difference between these modes is seen in the synchronization skew between Master device and the Output device and in EX1629 software setup. See the *Routing Mode Configuration* section in this chapter for more information.

The two routing modes of the EX2108/16 are manually configurable via internal jumper switches. It should only be necessary to manipulate these jumpers during the initial system design. It is possible to enable both modes simultaneously, but doing so will consume the entire trigger bus. See the *Jumper Switch Configuration* section for more information.

Daisy-Chain Extender Mode

One signal routing mode acts as a transparent trigger chain extender. In this mode, EX1629 software setup need not be modified, thus simplifying system expansion. The resulting software simplicity, however, results in a system synchronization performance trade-off due to the synchronization skew present between the Master Chain and the Output Chains.

Daisy-chain extender mode transmits the master input signals on channels 0 through 3, or the lower nibble, of a TRIGGER PORT. The Master Chain does not output buffered versions of the incoming signals, unlike in hybrid star/daisy-chain mode. Devices on the Master Chain can respond to the trigger bus signals before the signals are rebroadcast from the EX2108/16. The synchronization skew experienced is dependent on the length of the cable between the Master and the EX2108/16. This may or may not affect the measurement system depending on the synchronization requirements.

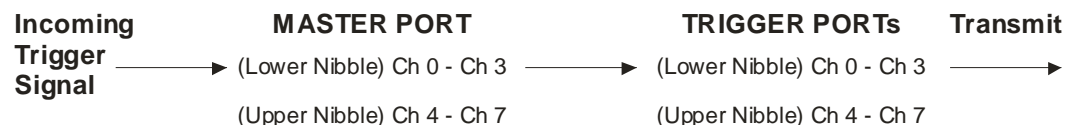


FIGURE 3-2: DAISY-CHAIN EXTENDER TRIGGER PROPAGATION

Hybrid Star/Daisy-chain Mode

The second signal routing mode acts as a star trigger bus hub. This mode eliminates the synchronization skew created in the daisy-chain extender mode by providing a loopback to the Master Chain. This routing mode allows the Master Chain to use the loopback signals from the EX2108/16 instead of the original Master synchronization signals. In this mode, the master loopback signals have the same synchronization skew as the other Output Port signals resulting in a low synchronization skew between the chains.

In the hybrid star/daisy-chain mode, the master input signals are rebroadcast on channels 4 through 7, or the upper nibble, of both the MASTER PORT and the TRIGGER PORTs. The MASTER PORT receives signals on the lower four channels. This mode requires the EX1629s software to be modified to allow the master signals to loopback into the Master Chain devices on different channels than they originate.

A modified version of the hybrid star/daisy-chain routing mode reduces the necessary software changes to only the Master Chain. In this version, the MASTER PORT receives the synchronization signals on the lower four channels of the trigger bus and rebroadcasts the signals on the upper four channels of the Master Port trigger bus only. On all the TRIGGER PORTs, the signals are rebroadcasts on the lower nibble as they are in the daisy-chain extender.

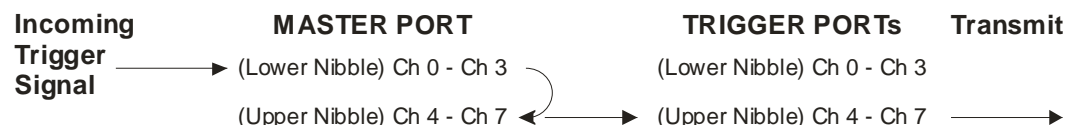


FIGURE 3-3: HYBRID STAR/DAISY-CHAIN TRIGGER PROPAGATION

An additional setup allows the TRIGGER PORTs to rebroadcast the signals on both the lower and upper four channels simultaneously. This configuration grants the software enough flexibility to switch between both modes, but consumes the entire trigger bus on all chains.

Jumper Switch Configuration

Configuration jumper switches allow each port on the EX2108/16 to be set individually. Figure 3-4 and Figure 3-5 show the possible configurations. Although different modes may be configured for each port, all ports, typically, would have the same configuration.

The jumper switches on the EX2108 are labeled JS1 through JS15 as shown in Figure 3-4. The jumper is labeled with a **Pnxx** identifier. **Pn** indicates the *port number* the jumper will affect, where **n** can take on a value between 0 and 7, inclusive. The **xx** indicates whether the port will use the upper nibble (UN) or the lower nibble (LN) when listening to the trigger bus. Note that the MASTER PORT only utilizes the upper nibble. To enable the output for a particular nibble, move the jumper switch toward the **Pnxx** label. To disable the output, move the jumper toward the JSn label.

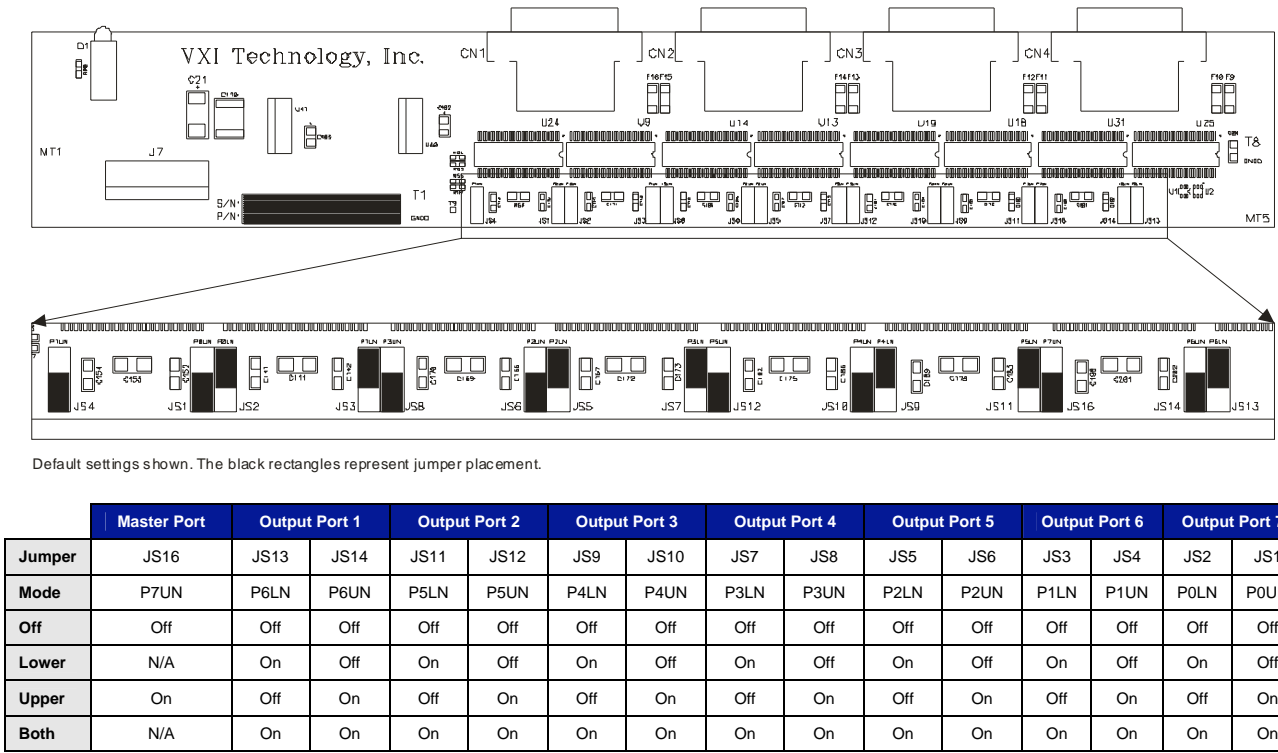
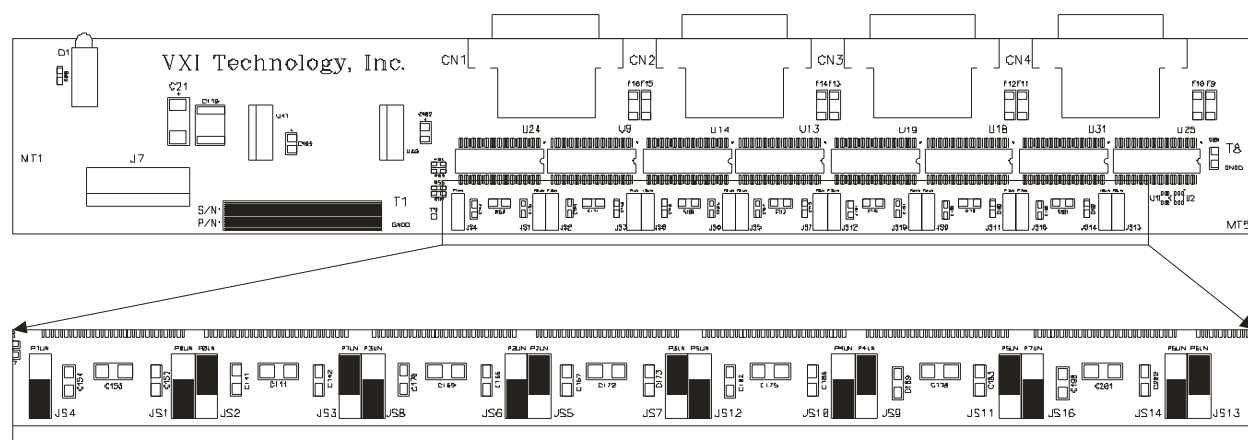


FIGURE 3-4: EX2108 JUMPER LOCATIONS & MODE CONFIGURATION

The jumper switches on the EX2116 are labeled JS1 through JS31 as shown in Figure 3-5. The jumper is labeled with a **Pnxx** identifier. **Pn** indicates the *port number* the jumper will affect, where **n** can take on a value from 0 to 15, inclusive. The **xx** indicates whether the port will use the upper nibble (UN) or the lower nibble (LN) when listening to the trigger bus. Note that the MASTER PORT only utilizes the upper nibble. To enable the output for a particular nibble, move the jumper switch toward the **Pnxx** label. To disable the output, move the jumper toward the JSn label.



Default settings shown. The black rectangles represent jumper placement.

	Master Port	Output Port 1		Output Port 2		Output Port 3		Output Port 4		Output Port 5		Output Port 6		Output Port 7	
Mode	P15UN	P14LN	P14UN	P13LN	P13UN	P12LN	P12UN	P11LN	P11UN	P10LN	P10UN	P9LN	P9UN	P8LN	P8UN
Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Lower	N/A	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Upper	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On
Both	N/A	On	On	On	On	On	On	On	On	On	On	On	On	On	On

	Output Port 8		Output Port 9		Output Port 10		Output Port 11		Output Port 12		Output Port 13		Output Port 14		Output Port 15	
Mode	P7LN	P7UN	P6LN	P6UN	P5LN	P5UN	P4LN	P4UN	P3LN	P3UN	P2LN	P2UN	P1LN	P1UN	P0LN	P0UN
Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
Lower	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
Upper	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On
Both	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On

FIGURE 3-5: EX2116 JUMPER LOCATIONS & MODE CONFIGURATIONS

SYNCHRONIZATION SKEW

When setting up a system with a trigger bus expander, synchronization skew must be taken into consideration. It is most pertinent when tight synchronization is required throughout a system. Accounting for this delay can complicate system configuration, but, by making these considerations, tighter system synchronization can be achieved.

If a system with a single trigger bus expander is required, the only configuration decision that must be made is whether to use the daisy-chain extender or hybrid star/daisy-chain mode. This issue mainly affects the complexity of EX1629 software setup versus the Master Chain to Output Chain delay.

Figure 3-6 shows a typical system using an EX2108/16 in daisy-chain extender mode. To simplify the discussion, it will be assumed that cables of equal length are used for all connections. The Master generates a synchronization signal at time 0 ($0 t$). In daisy-chain extender mode, the Master receives the signal at time 0 because internal signals paths are used. The signal must travel one cable length before it reaches the EX2108/16. The time it takes for the signal to cross the cable is referred as the propagation delay time ($1 t_{pd}$). Devices connected to the TRIGGER PORTs of the expander will experience twice the propagation delay time ($2 t_{pd}$), as the signal must travel through two cables lengths before reaching the devices. The more cable lengths that exist between the Master and the devices on the Output Chains, the greater the synchronization skew.

Synchronization skew is directly proportional to the sum of the cable lengths in a given chain. Although the VTI trigger bus cables are designed to minimize propagation delay, it is best practice is to use the shortest cables possible when setting up a system.

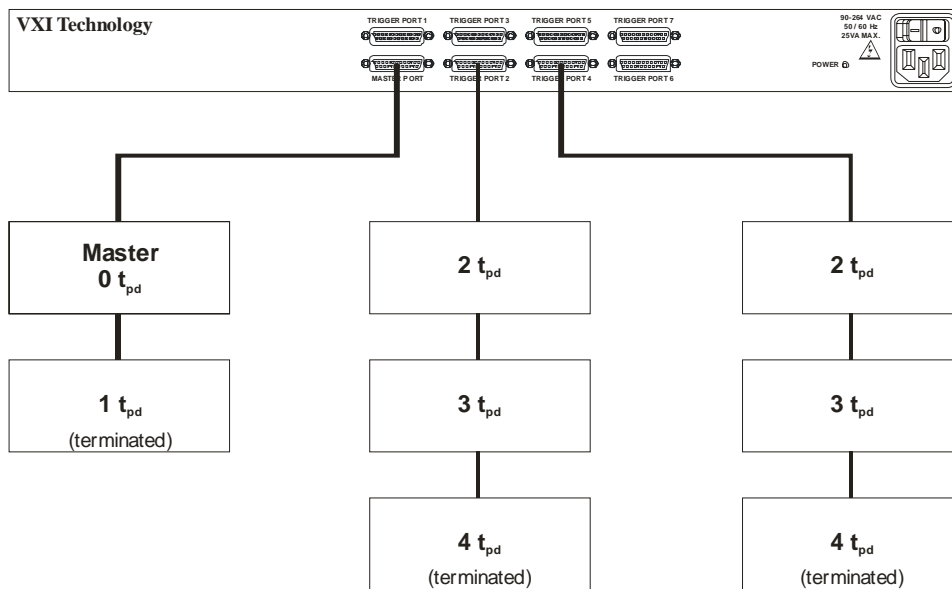


FIGURE 3-6: DAISY-CHAIN EXTENDER MODE

In hybrid star/daisy-chain mode, the synchronization skew of the Master Chain differs from the delay times experienced using daisy-chain extender mode. Figure 3-7 details these delay times. Note that the propagation delay times for the Output Chains remain unchanged. The Master Chain now experiences the same time delay as the other Output Chains, thus eliminating the synchronization skew between the Master Chain and the Output Chains.

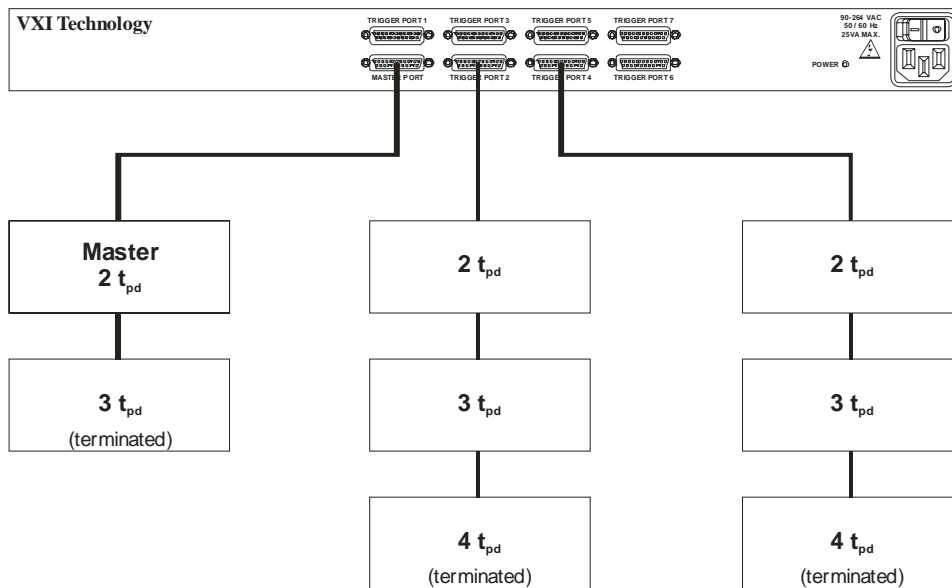


FIGURE 3-7: STAR TRIGGER HUB MODE

When using multiple EX2108/16 modules, the propagation delay time between each trigger bus expander creates another variable in system construction. The time delay between the two EX2108s is, again, due to the propagation delay of the cable.

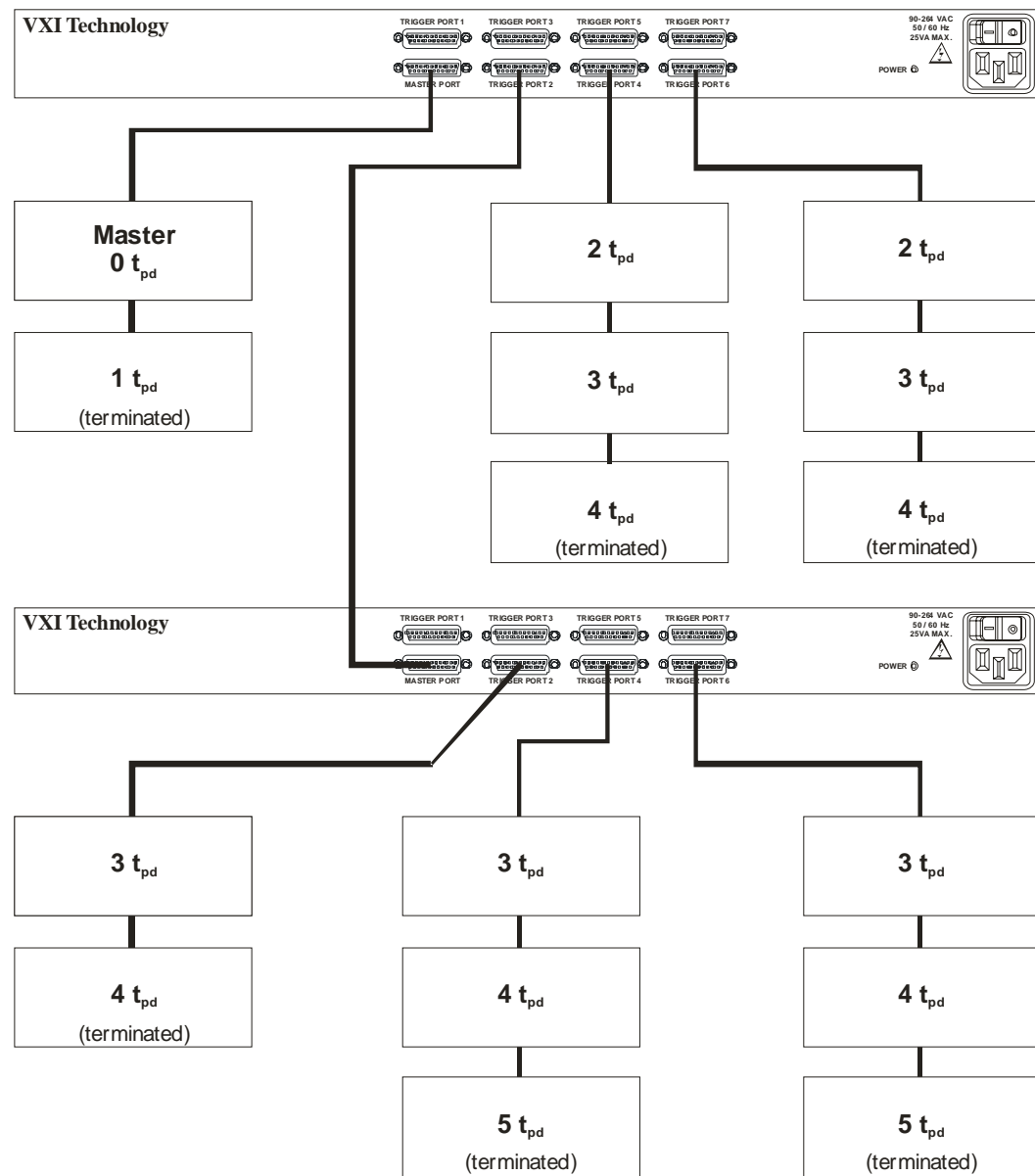


FIGURE 3-8: MULTI-EXPANDER SYSTEM

NOTE

In a multi-expander system, secondary expanders must be configured for daisy-chain extender mode, as the master loopback can only be sourced from an EX2108/16 connected directly to the Master Chain.

In multi-expander configurations, worst case synchronization skews can be minimized by placing the Master device as close to the center of the system as possible. This shortens the total distance to all the system edges. This worst case propagation delay is to the furthest device away from the master in the system.

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